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T H E

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THE SMALLER FUNGI.*

BY JOHN L. RUSSELL.



ALMOST everybody supposes that there can be no doubt as to what a toadstool, a mildew or a mould is, and some may even correctly call them fungi, if they are acquainted with the Latin word, which denotes them. Rust on grain, and smut on maize or Indian corn, are also familiar to farmers, but a multitude of other of the smaller fungi, are only known to the botanist. An accurate knowledge of them is to be found only with the mycologist, who as a botanist, devotes unceasing and strict attention to this particular department of natural history. Abroad it is to the researches of many eminent men and women, on the continent and Great Britain, and in this country to several others both dead and living, that the structure, mode of growth, relation to the various departments of industry, injurious effects and general utility of these smaller fungi in nature, are collected and known.

As plants, though of a very low order of organization, the smaller fungi treated of in the work before us, are of great interest as mere objects of beauty. To attain a full comprehension of this fact, recourse must be had to the microscope,

*Rust, Smut, Mildew and Mould. An Introduction to the Study of Microscopic Fungi, by M. C. Cooke, with nearly 300 figures by J. E. Sowerby. London. 12mo, pp. 238, 1865.

Entered according to Act of Congress, in the year 1868, by the PEABODY ACADEMY OF SCIENCE, in the Clerk's Office of the District Court of the District of Massachusetts.

because the several portions of these structures are beyond the reach of the unaided vision. No one, who does not know, could possibly conceive that the little specks of brown or black seen on the brilliant and ripening foliage of the maples in September and October, (or to be seen on the skin of apples and pears, and many kinds besides on dry stalks of plants, on straw, on old decaying matter,) on the fence rails, on the panes of the window, on the bodies of diseased house-flies, on putrefying and decaying matter, are receptacles of exquisitely sculptured and carved seed-vessels, called *spores*; beaded thread-like strings of pearls; or of myriads of the most fantastic shapes that the genius of man in imitative or creative art has developed. A subject so broad, and one which can be investigated at any season of the year, inviting the botanist forth from earliest spring to latest autumn, to search for forms of beauty on every living or ripening leaf and fruit, and in winter rendering the evening lamp still more attractive in studying by its aid the collected treasures of the summer's gleanings, cannot but interest every thoughtful person in some way or other, if it should be presented in an agreeable manner, or with reference to the industrial pursuits of society.

Nor only to the general botanist, or even to the botanist whose speciality is the study of fungi, is this subject one of more than ordinary interest. Some slight acquaintance with a few of these wonderful little plants, would render the walk for exercise or pleasure ten times more valuable and remunerative. Who has not noticed so early in summer as some bright, sunny day in June, along the dusty roadside where the blackberry vines creep among the weeds and grass, their leaves powdered beneath with rich golden dust, shaken from little orange colored cups? And many is the enquiry from many a child, or even older person, that I would tell them what such a phenomenon were. The leaves of the barberry bushes too, with their extraneous adornments, when the fruit is tempting men and women, lads and maidens

alike, to the old stone-walls and rocky pastures ; the leaves of the quince bushes in the garden ; of the thorn bushes in the fields, how strangely distorted by curious forms. The wearied looking and dusty lilac bushes, so dusty at the end of summer that no rain can wash them clean, nor even will, so long as the egg-mould riots on the upper surfaces of their leaves ; the crystalline drops of permanent dew glittering in the morning sun and which surmount many a tuft of equally crystal threads in countless numbers, issuing from some rejectamenta or waste matter ; these and many, and more beside, often attract attention as we stroll or walk for exercise or pleasure, but are soon forgotten, because nothing is known of them ; and who is there to tell ? Cunningly, wisely, and full of a secret, hidden meaning, a thousand forms of the lower vegetable life, look up into the faces of pedestrians who, with repressed curiosity, and not quite willingly, tread them under foot. They are leaves of the great folio, marginal notes on the pages of the book of Nature, often and to many, and for a long period to every one, hieroglyphs whose deciphering would repay all the requisite toil. "How thankful I am to you," said a friend, "that you have told me so much about these beautiful, though dry and fragile lichens, which carpet the old pastures ; they no longer can taunt me with their presuming pride, that they are something beyond my acquaintance." "The best lectures on botany," said the well-known educator, Geo. B. Emerson, once in conversation, "is after a plan pursued by a friend, who in the fields discourses on the structural differences of whatever plant he meets." "Different kinds of plants, enough to occupy your life time, are now under my hand," said Linnæus, a hundred years ago, as the anecdote is told. What would the Swedish savant say now, when on the leaf of the elm alone, more than a dozen species of minute fungi are to be found ? In a basket of wet mosses, lay through the night and part of the next day, a large agaric, with a few patches of a white mould attached, which, in that space of time, completely matted by its

rapid growth of intricate fibres, every surrounding object, revealing in the smallest bit of itself the forked branches and spores of a species of *Peronospora* with its two-formed fruit, any single one of which falling on the living tissue of moss germinated and bore fruit in turn! A few hours dampness and heat will develop the *Botrytis* and load its slender stalks with grape-like bunches of seed-bearing cells.

With an intention to introduce these little parasitical growths to the attention of the reading and thinking public, to such as would readily attend lectures illustrating such topics, and to make plain and easy, what at first seems so obscure and mysterious, the author commences by bringing forward some of the species most common in England, and explaining by words and by figures their form, structure and occurrence. We have only to change the words a little and designate the fields close to any large town or city of the United States, or at least of New England, to find the same or similar living plants, whose foliage or other parts of them are infested with the same species or with kinds closely allied.

"Amongst the six families into which fungi are divided, is one in which the spores are the principal feature. This family is named *Coniomycetes*, from two Greek words meaning 'dust fungi.' This family includes several smaller groups, termed orders, which are analogous to the natural orders of flowering plants. Without staying to enumerate the characteristics of these orders, we select one in which the spores are enclosed in a distinct *peridium*,* as in our typical plant they are contained within a sort of cup-like excrescence. This order is the *Æcidiacei*, so-called after *Æcidium*, the largest and most important of the genera included within this order. The *Æcidiacei* are always developed on living plants, sometimes on the flowers, fruit, leaf-stalks, or stems, but most commonly on the leaves, occasionally on the upper surface, but generally on the inferior. The different species

* *Peridium*, the covering of the seeds of fungi.

are distributed over a wide area ; many are found in Europe and North America ; some occur in Asia, Africa, and Australia." (pp. 5, 6.)

The Rev. Dr. M. A. Curtis, in his Catalogue of Plants of North Carolina, published at Raleigh, in 1867, furnishes us with as many as thirty species, to be found on the leaves of as many different living plants. Other lists in different parts of the United States give us still other species infesting other kinds of plants. Thus Schweinitz, in his "Synopsis of North American Fungi," mentions or else describes forty-one distinct species, which grow upon the leaves and other parts of native plants. From these let us select his *Æcidium ranunculacearum*, which attacks the foliage of various kinds of the buttercups, or *Ranunculus*. This fungus is likewise found in England, and listen to what our author writes about it :

"It is found on several species of *Ranunculus*, as *R. acris*, *bulbosus*, and *repens*. The leaf is thickened at the spot occupied by the parasite, and generally, without indication, on the opposite surface. Sometimes one spot, at others several, occur on the same leaf. The peridia are densely crowded together, often arranged in a circinate manner, *i. e.*, like a watch-spring. The seeds (spores) are orange, but slightly varying in tint on different species of *Ranunculus*."

The several species of *Ranunculus* here cited, though introduced plants, have become common in this country, and serve to enamel with golden blossoms our own meadows and fields. The swelling or excrescence upon the leaves, thus technically called peridium, as we have before noticed, splits at the top into many points or teeth, and renders it a pretty fringed cup filled with the yellow spores. On this account the *Æcidiums* are termed cluster-cups, the more so, especially when they are arranged in clusters upon the leaf. Of a species which in England infests the leaves of the "Goat's-beard" (*Tragopogon*), we are informed that "the spores in this species are orange, sub-globose, sometimes angular, and

indeed very variable both in size and form, though the majority are comparatively large. Each of these bodies is, doubtless, capable of reproducing its species, and if we compute 2,000 cluster-cups as occurring on each leaf, and we have found half as many more on an ordinary sized leaf, and suppose each cup to contain 250,000 spores, which again is below the actual number, then we have not less than five hundred millions of reproductive bodies on one leaf of the Goat's-beard to furnish a crop of parasites for the plants of the succeeding year. We must reckon by millions, and our figures and faculties fail in appreciating the myriads of spores which compose the orange dust produced upon one infected cluster of plants of *Tragopogon*. Nor is this all, for our number represents only the actual proto-spores which are contained within the cups; each of these, on germination, may produce not only one but many vegetative spores (sprouting buds), which are exceedingly minute, and individually may be regarded as embryos of a fresh crop of cluster-cups." (pp. 7, 8.)

The stems and leaves of the sweet violets, and of the several scentless ones beside, are distorted and ruined by other cluster-cups; the stinging nettle does not escape; the hardy dock, the useful currant, the wild geranium alike, feed with their juices other kinds, and a wide field of observation is offered to the lover of the microscope, to detect and discover other and yet unknown native sorts. However, "let us warn the young student against falling into the error of supposing, because the specific name of the fungus is derived from the plant it infests, that therefore the species differs with that of the plant, and that as a rule he may anticipate meeting with a distinct species of fungus on every distinct species of plant, or that the parasite which he encounters on the living leaves of any one plant is *necessarily* specifically distinct from those found on all other plants. The mycologist* will look to the specific differences in the parasite with-

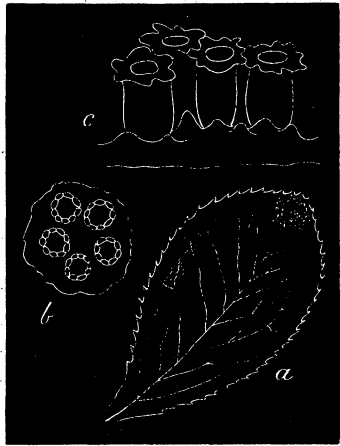
*Mycologist, one who exclusively studies fungi.

out regard to the identity or distinctness of the plant upon which it is a parasite." (p. 6.)

It is an old and erroneous opinion which some of our farmers yet entertain, and which they have received by tradition from their ancestry, who brought it with them from the "old country," that the cluster-cups on the leaves of the barberry were capable of producing the blight and mildew upon grain, and that as an exemption from, or security against, such a fate, every barberry-bush should be effectually exterminated from the grain-fields, if, by careless husbandry or purposely for its fruit, it should be found bordering them.

"This opinion," says our author, "even received the support of Sir Joseph Banks, but no fungi can be much more distinct than those found on grain crops, and this species on the leaves of the barberry.* In this instance the cups are elongated and cylindrical, and the spots on the upper surface of the leaf are reddish, bright, and distinct; the teeth on the edge of the cup are white and brittle, and the orange spores copious." (Fig. 1; *a*, leaf of barberry, with cluster-cups, *Æcidium berberidis*; *b*, a portion magnified; *c*, the same seen sidewise).

Fig. 1.

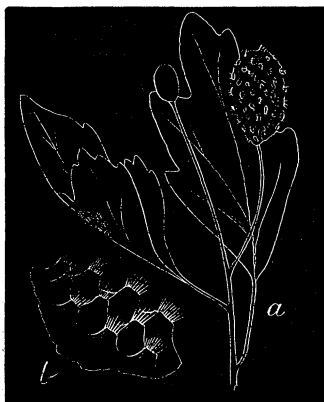


Very singular and curious clusters of excrescences occur on the leaves of the apple tree, pear tree, and mountain-ash bush, and are very prominent on the leaves of the quince tree, and especially of the wild apple tree of the West, consisting of large peridia, pointed at the tops, and so swollen below as to bear a rude resemblance to urns, the edges split into

*This fungus and *Puccinia graminis* have been recently determined by Professor CErsted to be one and the same plant. See Dr. Lütken's Review in the preceding number of the NATURALIST.

long and contorted threads. They are species of *Ræstelia*, the *R. lacerata* (Fig. 2; *a*, natural size, living on the leaves and fruit of the hawthorn; *b*, a portion magnified), *cancel-*

Fig. 2



lata, *mali*, *cornuta*, and of the *Centridium cydonia*, the spores of which are of a light orange color. The leaves of the pine and fir are sometimes attacked by the *Peridermium*, which in two species alters the foliage and spoils the effect of the branches. "In this genus the peridium bursts irregularly, and does not form cups or horns or fringed vessels." The *P. pini* has been frequently noticed in this country. The

common houseleek is, in England, attacked by a parasitical fungus of this family, which burrows in the pulpy tissue of its thick and succulent leaves, and hence called *Endophyllum*; but I can find no notice of its occurrence with us. "We have derived much pleasure," says Mr. Cooke, "in viewing the astonishment and delight exhibited by friends to whom we have personally communicated specimens of the little fungi we have enumerated for examination under the microscope; and we recommend with confidence this group of parasitic plants, unfortunately so little known, as well worthy the attention of all who are interested in the minute aspects of nature, and who can recognize the hand

'That sets a sun amidst the firmament,
Or moulds a dewdrop, and lights up its gem.'" (p. 21.)

To which we can but add our hearty assent, and only wish that investigations and studies so prolific of gratification were more universal, especially among the young.

The spores of these smaller fungi have been spoken of as a sort of seeds by which the plants to which they belong are propagated. This, as we shall now see, is not strictly true,

and several novel and interesting points for consideration and even for enquiry arise. If we should place some of the yellow dust, which fills the cup-shaped peridia in a drop of water, and prevent its evaporation by covering it with a bell-glass, a tumbler or wine-glass would do as well, we should find, in a few hours, that each particle of the dust had swollen, and bursting at some point, had given out a blunt thread, at the apex of which, it is crowned with delicate curved appendages, which soon become connected by lateral threads, thus forming a kind of latticed net-work, and from the sides of these filaments little oblong cells sprout, which in turn germinate and reproduce the plant. For this highly interesting discovery we are indebted to the Rev. M. J. Berkeley of England, and a particular and extended account of which may be found in the London Journal of Horticulture, vol. 2, p. 107. Those of our readers, who are familiar with the early stages of the ferns can trace a striking analogy in the process.

In many of the smaller fungi, the first condition of the germinating spore, viz. : the cluster of curved and delicate appendages surmounting a thread, is present in another form, and constitutes what is termed the *Spermogone*,* often in the shape of a minute dot near the peridium and sometimes on the opposite surface of the leaf, and in fact a conceptacle or blister filled with threads, and throwing off from the apices the curved bodies, called *spermatia*, which escaped through an orifice provided for the purpose. Before the nature and office of these singular objects were known, spermogones were mistaken for distinct kinds of fungi, and many diverse species were described. They are, however, not wholly confined to the fungi, but even the lichens are furnished with similar ones. The size of the largest spermatia, those of the *Peridermium pini*, "have a length equal to $\frac{1}{5200}$ of an inch, but their width seldom exceed $\frac{1}{100000}$ of an inch,

* *Spermogones*.—pustules and depressions like pockets, containing *Spermatia* or germinating filaments.

whilst on others their length does not exceed the width of those just named." (p. 25.)

The evident effort of nature, then, in this process, is to produce an ultimate condition of fungal life, which shall be sure to continue indefinitely the presence of the parasites upon the leaves and other parts of the higher plants. And this is done by the *mycelium*,* a system of the most subtle threads which can enter the tissues by attacking the seed when sown, and whose persistence of vitality enables it to endure the most trying circumstances unharmed. So vitalized indeed is the mycelium, that any fragment of it will vegetate and grow after long periods of desiccation. And its luxuriance of growth is in nowise dependent on any higher development, such as, were it the stems and leaves of, a flowering plant, would sooner or later push forth blossoms and fruit.

This vitality is taken advantage of in the cultivation of the edible fungi, such as the mushroom for example, where lumps of dried earth, permeated by the mycelium or "spawn," as it is technically called, are planted in prepared soil, and a profitable crop realized. It is also familiar to cultivators, that fruit trees and ornamental trees often languish and die, owing to their roots reaching spots deep in the ground where decayed wood, filled with the "spawn" of some destructive fungus exists. Fortunately the awakening to active life, and to injurious growth, seems to depend on causes which do not always exist, such as atmospherical and similar conditions, else there were no chance of security from these annual scourges of agricultural industry. Fungi of every kind are therefore regarded as meteorological phenomena; like a few of the higher plants, which appear at wide intervals, and then, sparsely. — *To be concluded.*

* *Mycelium*, the fibrous portion of fungi, which grows underground or in the tissues of the plants upon which they are growing, and sometimes under the bark of living or dead plants.